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HIGH PRESSURE PRESSING TECHNIQUE FOR SOLVATED CYCLOTRIMETHYLENE--ETC(U)
MAY 80 R Y YEE, A ADICOFF, D M PEARL
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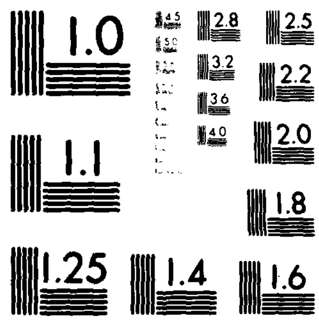

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High Pressure Pressing Technique for Solvated Cyclotrimethylenetrinitramine (RDX) and Cyclotetramethylenetetranitramine (HMX) Pellets.

(10) by
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FOREWORD

The high pressure pressing technique was originally developed to prepare test specimens for wettability and surface chemistry studies. It can also be used to prepare specimens for other purposes. Examples include the tough, dense explosive pellets required for boosters and the neat explosive pellets needed for explosive testing such as in burning rate studies.

This work was initiated in January of 1978 and completed by July 1979. It was part of a project ~~funded under~~ Task SF33-354-316.

This report was reviewed for technical accuracy by Eugene C. Martin.

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~~(U)~~ A technique for preparing high density, mechanically strong explosive pellets without any binder is described. It involves pressing under high pressure (51.6 MPa) and the use of acetone as a solvating liquid. For cyclotrimethylenetrinitramine (RDX), the pellet density obtained is 98% of the theoretical density of the pure crystals. Pellets of cyclotetramethylenetetranitramine (HMX) can also be prepared the same way. The residual acetone in the pellet is negligible for most applications. The procedure is a batch operation with pressing time 2-10 minutes.

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INTRODUCTION

This paper describes a technique to prepare explosive pellets that have high density, are mechanically strong and do not contain any binder. In the preparation of explosive pellets for boosters, it is often necessary to use a binder to cement the explosive together. The function of the binder is twofold: (1) to facilitate the pressing and achieve high density; (2) to improve the texture of the pellets so they can withstand normal handling without falling apart. The binder is usually lower in energy than the explosive and its use reduces the energy output of the pellets. Therefore, a technique which produces high density, tough pellets without any binder, is desirable.

In explosive testing such as burning rate study it is important to use neat explosive pellets so the effect of the pure explosive properties prevails. The presence of a binder adds some complication to data analysis. Explosive pellets are also used in surface property study by contact angle measurements in this laboratory. This type of study also requires pure, high density pellets. The high pressure solvent pressing technique described here was originally developed to prepare test specimens for contact angle measurements in our laboratory.

EXPERIMENTAL AND RESULTS

The pellets are pressed in a die using an hydraulic press which maintains a preselected constant pressure automatically. The die initially used is a 1.27-cm-(1/2-inch-) diameter stainless steel die with 2.54-cm-thick wall. In order to remove the pellet without extruding it, a "break-away" die was fabricated. The structure of the die is illustrated in Figure 1. All the parts were made from stainless steel and heat treated for hardness. Pellets of cyclotrimethylenetrinitramine (RDX) and cyclotetramethylenetetranitramine (HMX) have been prepared. The particle size of the materials used to prepare the pellets was less than 100 microns. The solvating liquids used include acetone, dimethylsulfoxide, cyclohexanone and acetonitrile. Judging from the density and texture of the pellets, acetone is the best solvent for RDX and HMX. It is also easily removed from the finished pellets. The pressing procedure and properties of the pellets are described below.

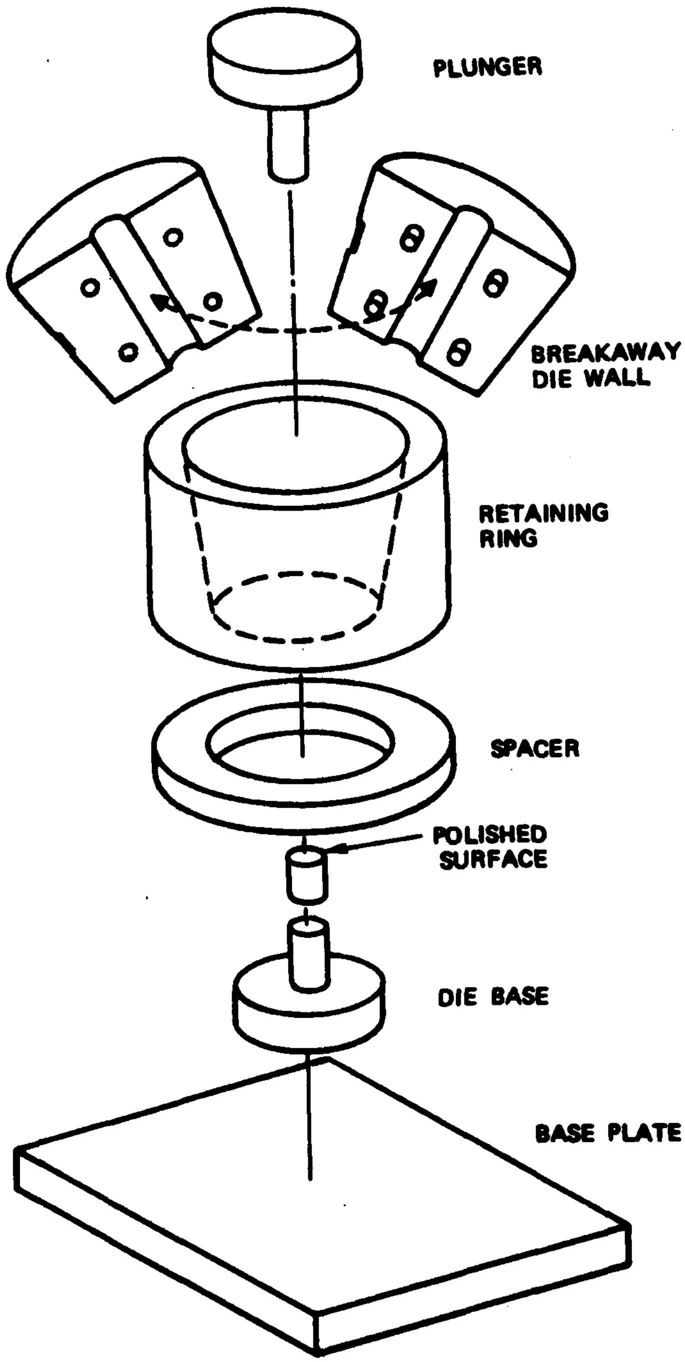

FIGURE 1. Break-away Die.

A. PRESSING PROCEDURE

Half a gram of RDX was introduced to the 1.27-cm-diameter die and the top of the material was slightly leveled using a spatula. Two drops of acetone were added. The plunger was then inserted and the die assembly transferred to the press. The pressure was increased to 51.61 MPa (80,000 psi) in about 20 seconds. This pressure was maintained for 10 minutes. The pressure was then released and the die opened for removal of the pressed pellets.

Pellets weighing up to 1 gram have also been prepared. The procedure was slightly changed when 1-gram pellets having a smaller diameter (0.97 cm) were pressed. Half the amount of the explosive powder was introduced to the die; one drop of acetone was added. The remaining powder was then added and the second drop of acetone added on top. This was done to more uniformly wet the powder. The remaining procedure was similar to that described above. A similar procedure is used for HMX pellets.

B. PROPERTIES OF THE PELLETS

The density of the pellet was determined from accurate measurements of weight and dimensions. The density was in the range of 1.71-1.77 g/cc for RDX, which was 95-98% of the theoretical density of the pure RDX crystals. Most of the acetone was pressed out of the pellet while under pressure. The weight of the pellet was constant after 2 hours under ambient conditions. For applications where the presence of acetone was of concern, a pellet was heated in a vacuum oven at 60°C for 2 days. The pellet was then dissolved in dimethyl sulfoxided_6 and the acetone content determined by proton nuclear magnetic resonance (NMR) to be less than 8 ppm. The pellets are very hard and will withstand normal handling. They can be shaved without cracking. It was possible to reduce the pressing time to 2 minutes. Pellets pressed for only 2 minutes were still very strong but their densities were about 1-2% lower than those from the 10 minute pressing time. Similar results were obtained for HMX pellets except their densities never exceeded 96% of the theoretical value.

DISCUSSION

The high pressure solvent pressing technique does not require a binder to hold the pellet together as in the case of the conventional pellets. As a result, the density of the pellets is higher and the energy output will be higher. For comparison, the densities of typical RDX and HMX pellets are listed below with those for a conventional tetryl pellet.

	Density (g/cc)	Percent of theoretical density (%)
High pressure solvent pressed HMX	1.82	96
High pressure solvent pressed RDX	1.77	98
Tetryl	1.60	89

For fundamental studies, it is often important to measure the properties without the complication of foreign materials in the pellets. This high pressure solvent pressing technique is especially suitable for preparing neat explosive pellets. Pellets of neat explosive have previously been prepared using high pressure, but they are mechanically very weak and crumble very easily. This not only requires special handling, but can also give misleading results due to the effect of the pellet breaking during tests. A solvent pressing technique is also known at the present time.[1] This technique uses a vacuum system under low pressure and takes a long pressing time (on the order of hours). The high pressure solvent technique described in this report is simpler to operate and is faster. The 2- to 10-minutes pressing time and no vacuum enables one to prepare pellets for tasks that require a large number of pellets. This technique can be used to prepare other neat explosive pellets. The only requirements are that the explosive be stable under the high pressure and that a suitable solvent be used.

[1] M. Finger, Lawrence Livermore Laboratory, University of California, Livermore, Calif., private communication.

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